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Rewired by the WOD?

As researchers start to close in on the causes of autism, some CrossFit gyms are testing treatment theories that suggest exercise can help.

(Corrects to clarify that some children with Asperger's, not all, are averse to touch.)

By Chris Cooper **April 2014**

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Living with autism is about making connections.

Since the earliest diagnosis of autism in 1911, parents have searched for ways to relate to children whose symptoms often make interaction challenging. With no cure for the developmental disorder, treatment plans can include behavioral

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management and even institutionalization. But new brain-mapping technologies, behavioral strategies and physical therapies are closing in on the condition from different angles. And many new recommendations include exercise to help with social skills, cognition and health.

"When someone in your family is diagnosed with autism, it becomes the central thing in everyone's lives," said Brian Costello, owner of CrossFit Long Island. Costello coaches two groups of kids with autism every week, including his brother Danny. Both Costello brothers love the group, and the workouts might be helping Danny with more than muscular strength.

With autism diagnoses occurring at an increasing rate, more parents and researchers are now asking if exercise can improve the lives of those who live with the disorder.

The Connectivity Matrix

When viewed from the top, the human brain looks like a walnut: two large lobes, or hemispheres, partially separated by a split down the middle.

Though physically identical, the right and left hemispheres of the brain specialize in different things. Creative tasks—composing a blog post, conceptualizing a painting, brainstorming lyrics—are more typically associated with the right hemisphere. Logical functions—calculation, translation, sorting of data—are usually done in the left. The left hemisphere controls the right side of the body, and vice versa.

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While autism currently has no cure, some researchers suggest exercise can help reduce its symptoms.

But while pop psychology would have us believe one side of your brain is "dominant" over the other, it's not that simple. When you write a note, your right hemisphere forms the tone and considers the social repercussions. The left hemisphere translates your thoughts into language. When your right hand types, it's controlled by the left hemisphere; meanwhile, the right hemisphere tells the left hand to stay still. Both hemispheres work together for almost everything, and the corpus callosum is their link.

A thin band of white matter, the corpus callosum is the real information superhighway, carrying information from right to left and back through about 250 million electrical connections. Einstein's brain was the same size as yours, but his corpus callosum was extraordinarily thick with connections, allowing him to take an idea or concept (right hemisphere) and explain it in an equation (left hemisphere) better than most (4).

> "If you can't explain it to a 6-year-old, you don't understand it yourself."
>
> —Albert Einstein

Cooperation between hemispheres means when a woman suffers brain damage on the left side, she might still relearn math using the same region on the right side. But it also means the brain is heavily reliant on the delivery path to share information accurately, quickly and with the correct priority. Researchers now believe the corpus callosum, entrusted with all that information, may function differently in people with autism.

Too little connection is obviously bad. But too much connection, especially to the wrong area of the brain, can be worse (7).

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Pruning Unnecessary Connections

Crossing the Nile in a rowboat is hard. But if you wanted to make it harder, you could try adding 250 million other rowboats.

Lucina Uddin, Ph.D., of the University of Miami is counting the connections in human brains. She said the problem might not be a lack of connectivity but a lack of pruning the wrong connections (8).

"There's a prevailing underconnectivity idea in autism that the brain structures aren't communicating with each other, that there are less connections. That's been the theory for 10-15 years, but that's mostly based on work in adults in autism. When you look at their brains, you tend to see reduced connections between different regions," Uddin said. "But we started looking at younger kids, specifically 7-12 years old. Their brains are actually overconnected compared to their developing peers."

Your response to any stimulus changes as you age. Small children sometimes "make strange" with faces they don't immediately recognize. As familiarity grows, they drop the negative connection and soon forget Uncle Al's beard was once terrifying. This may not be the case with the autistic child.

"In typical development, you have overconnectivity early in life, and then connections get pruned away so that only specific important ones remain in the adult brain," Uddin said. "We have this idea that maybe that pruning process is delayed in autism, so the young kids are overconnected and they're not getting rid of the unnecessary connections at a fast enough rate."

If a child is scared by Uncle Al's beard, he'll form a connection to the amygdala, which is responsible for the fight-or-flight response. It's the part of the brain that lights up when you see a snake, for example. As the child learns to trust Uncle Al, that connection is pruned and he's no longer afraid. But if the connection remains, the child might still be scared by the beard—even years later.

"Some regions are too connected to each other, and that could result in abnormal responses. The level of connectivity between specific brain regions is very critical—and the right level: not too much and not too little," Uddin said.

Further confounding the problem is the brain's hierarchal approach to responding to stimuli. The amygdala is usually consulted first—you react to a hot stove or a snake before you can even think about it—and that supersedes a

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During special classes at CrossFit Long Island, kids with autism learn movement patterns that might help them create new pathways in their brains.

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Inspired by his autistic brother, CrossFit Long Island owner Brian Costello uses his gym to help others with the disorder.

rational approach. You can't talk a child with autism into liking his Uncle Al, just as you can't convince someone that fire isn't hot.

"If there's too much activity in the amygdala, you might have anxiety or exaggerated fear responses or things like that," Uddin said.

Some autistic children have poor connectivity between the part of the brain (Wernicke's area) that responds to human voice and the part (Broca's area) that responds to reward (1).

"For most people, listening to a mother's voice is a rewarding process. In kids with autism, there's underconnectivity between the voice region and the reward region," Uddin said.

When a toddler is frightened by his Uncle Al, he cries. His mother picks him up and soothes him, she tells him Uncle Al isn't scary, and the child eventually comes around. But what if mom's voice doesn't help? What if it never will? Some studies suggest issues with amygdala function in autistics prevents them from linking appearances with knowledge and then engaging in an appropriate behavior (2).

Uddin said the same symptoms might be seen to a lesser extent in children who are at the edge of the autism spectrum. Children with Asperger's syndrome, for instance, might struggle with social interaction but have fully developed cognitive skills and language.

"A lot of high-functioning kids only have deficits with their social interaction, and they're pretty good with almost everything except picking up social cues. A lot of them just process social stimuli a little bit differently, even the ones with the high IQ," she said.

In these cases, behavioral therapies may work well over the long term because kids can unlearn their negative reaction to social contact. For example, some kids with Asperger's are averse to touch, but they can learn to manage their reaction to touch. Through therapy, they can literally rewire their response (6).

And exercise makes that rewiring easier.

Crossing the Midline?

If efficient connection across the corpus callosum is important to brain function, can we improve those connections? Can we stimulate the pruning of inappropriate connections and help new ones form? Can we condition children with autism to rewire their responses to stimuli? If so, where do we start?

Can we condition children with autism to rewire their responses to stimuli? If so, where do we start?

"These are the million-dollar questions," Uddin said. "We don't know where exactly the functional disconnections are, but we have a couple of candidates. We look at the regions of the brain that are specialized for processing faces or social cognition. They're underconnected in autism."

Conversely, the amygdala is often overconnected.

"Interhemispheric connectivity" describes the total number of connections made. "Interhemispheric coordination" describes how well those connections work together to form rational, appropriate action. And exercise can improve interhemispheric coordination (5).

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Though most table-tennis players aren't ambidextrous, they have to play equally well on both sides of their bodies. That requires a degree of interhemispheric coordination almost unmatched in other sports. Table-tennis players aren't born great; repetitive play, requiring a lot of processing in both hemispheres at once, builds up the corpus callosum much like a muscle grows with training. A lifetime of table tennis can turn an average corpus callosum into a finely tuned instrument. If interhemispheric coordination can be measured along a spectrum, with "average" in the middle, can performing exercises requiring the use of both limbs at once improve translation across the corpus callosum?

While some researchers, such as Carla Hannaford and Paul Dennison, make the case for midline-crossing movements to stimulate interhemispheric coordination, third-party objective data doesn't yet support their BrainGym program. Owned by Dennison, his wife and Hannaford, BrainGym prescribes 26 midline-crossing exercises to enhance interhemispheric coordination. The exercises "recall the movements naturally done during the first years of life when learning to coordinate the eyes, ears, hands, and whole body," according to the BrainGym website.

The theory of repeating "primal movement patterns" such as crawling is becoming popular in many children's exercise programs. While empirical observation and reporting is promising, hard data isn't yet available beyond research funded by companies who sell the exercise programs.

What several studies do support is the stimulation of brain-derived neurotrophic factor (BDNF) by exercise. BDNF helps with the formation of new neurons, the electrical impulses that form thoughts and memories (3). Dr. John Ratey, the author of *Spark: The Revolutionary New Science of Exercise and the Brain*, famously referred to BDNF as "Miracle-Gro for the brain."

Behavioral therapies for autism aim to correct inappropriate responses to stimuli. But they take a long time: one neuron linking to a "correct" response can easily be overwhelmed by 250 million linking to the "wrong" one. Exercise might dramatically speed up that process by forming new neurons—and pruning the old ones—faster. In other words, children with autism can rewire correct behaviors more quickly and overrule the negative responses. If the theory is true, then more behavioral therapy sessions should occur in the gym.

Ratey believes exercise has other positive effects on the brain.

"The 'core'—all your muscles to hold you straight or keep you taut—is also directed by this part of the brain called the cerebellum. The cerebellum is involved with memory, learning, social skills, emotion and attention," Ratey said in 2013. "If you are uncoordinated physically, some things are going to be out of whack intellectually and emotionally."

In spring 2013, Ratey was consulting for a Boston-area group of children with autism. His belief was the physical training would help the children be more focused.

"They are very uncoordinated, which is a big problem," he said. "Their cerebellums are off. But you can train the cerebellum, which is what you're doing all the time you're working on the core exercises. Even, thinking of CrossFit, doing the rowing—there's a core component to that and certainly most of the other exercises we do."

Kids with autism enjoy movement, but most are starting from a deficit. Vestibular development is impaired in autistic children, and learning better movement patterns can only help them live better lives.

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Researchers such as Dr. John Ratey are studying the effects of exercise on the brain and suggest fitness has a dramatic effect on learning.

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Is it Really This Simple?

Though many factors contribute to autism, research into the potential of exercise to mediate the effects of cognitive delay is promising. And one factor in its treatment overrides all others: the child has to like it.

Luke Brennan is a skinny teen who spends much of his time at CrossFit Long Island with his fingers in his ears. Even when the room is silent, he prefers to face the wall, orange cap pulled low, avoiding eye contact. He spends a lot of time seated, knees pulled up to his chest, barely peeking out at his coach.

Costello is that coach, and when he introduced his "hopstacle course" to his small class of teens with autism on March 15, Luke stood up and hopped in place. He hopped while waiting for his turn, and then he hopped from plate to plate for the length of the gym. Then he hopped back to the starting line, smiling. He didn't stop hopping until the drill was over. Then he plugged his ears and sat against the wall again.

"I want to keep it laid back," Costello said. "I want to make sure they leave here smiling."

Video: CrossFit and Autism: Walking out With a Smile by Mike Koslap

Costello's first group Saturday morning was new to CrossFit. Their energy was subdued; kids touched the walls, the rowers, the whiteboards and the rig, playing with J-hooks and rubbing chalk between their fingers.

> Their behavior, first driven by an irrational response to fear, has been altered by the CrossFit Long Island coaching staff.

The second group had done CrossFit before. These kids were smiling, knocking on the door to get in early, high-fiving the coaches. Costello witnessed the change—from anxiety to excitement—in this second group over their first few weeks of CrossFit.

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Costello keeps things relaxed during classes with autistic athletes. Similar to the goal of the CrossFit Kids program, Costello wants kids to leave with smiles on their faces.

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"They go from shy and reserved to happy and excited," he said. "They show up early. They talk about it all morning before they go to the gym."

If nothing else, these autistic athletes have improved their social integration in an active setting. The average adult's first exposure to CrossFit may make him or her nervous; these kids appear terrified. But the inverse is also obvious: the happy smiles at the end of an average CrossFit class are amplified into dancing, clapping and laughter in this group. Their behavior, first driven by an irrational response to fear, has been altered by the CrossFit Long Island coaching staff. It's behavioral modification with real-world application, and in many cases results are seen much faster than with typical therapies such as applied behavior analysis.

In his book *Teaching With the Brain in Mind*, Eric Jensen states movement will change the minds of students in several ways.

"Many special-needs learners are stuck in counterproductive mental states, and movement is a quick way to change them. Second, movements, such as those involved in playing active games, will activate the brain across a wide variety of areas. It may be the stimulation of those neural networks that helps trigger some learning," he wrote.

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Until science can prove exercise helps autistic kids, many parents will get their children moving simply because it's fun.

Exercise may help alter the brain's chemical and electrical systems. In many sciences, observation suggests a hypothesis before data can make its case for a theory. This may be one such case, and researchers will continue their work.

But in the meantime, providing a supportive environment of fun play might be the best way to help kids with autism. Ask the parent of any autistic child: a smile is rare enough to make them try anything.

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